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Smart monitoring information system based on RF 433 Mhz (SMIS)

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ABSTRACT

Many research works are devoted to the design of remote control systems of objects. Remote monitoring is among the technologies of data acquisition on a remote object and its characteristics without physical contact with it. These data can be collected by acoustic waves, the distribution of forces and electromagnetic energy to process them to locate the object and its characteristics. This paper presents a smart monitoring information system based on RF 433MHz, Arduinonano and arduinouno named SMIS.

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1. INTRODUCTION

The progressive development of the Internet of Things (IoT) [1] provides a smart environment that helps people in their daily lives. Deployment of dense and interconnected wireless sensor networks (WSNs) is critical to IoT implementation [2]. Object monitoring based primarily on wireless sensor networks [3]. Currently, its value has increased significantly in different areas, mainly in the control of rare and expensive items. Wireless communication [4] is a transfer of information over a distance wirelessly . This distance can be short [5] (a few meters) or long (thousands or millions of kilometers for radio communications). There are different technologies that are used in wireless communications and subsequently object monitoring, such as GSM [6], Wi-Fi [7], Bluetooth [8], ZigBee [9], 6loWPAN [10], etc.The monitoring system studied essentially requires basic modules, such as microcontroller, RF modules, and GSM module.

To implement the object in a monitoring field, it is necessary to identify the range between the transmitter and the receiver RF433MHZ, so that a function between the length of the antenna RF433MHZ and this distance is required. We will then attach a remote monitoring system to the object to control it in real time [11]. This system is based on an Arduino Nano, an RF433MHZ module, a GSM module and a BUZZER module. The rest of this paper is organized as follows:

In section 2, we will discuss the related works, in section 3 we present our proposed system SMIS, a Wireless Sensor And Actuator Network are presented in section 4, the experimental results of the function between the length of the RF 433MHZ module antenna and the distance between its receiver and its transmitter at the laboratory scale is discussed in section 5, Design and Implementation are presented in section 6, the paper will be conclude in section 7.

2. RELATED WORK

Healthcare area in recent years has been rapidly integrating technology in the monitoring, diagnosis and treatment of patients remotely. To improve quality of life of patient and to facilitates tracking of patient who needs real time data collection. Most studies reviewed point to a chronic disease monitoring in particular as in which are responsible for the first remote monitoring of vital signs and the second of a telemedical ECG system of a patient [12].

Other systems such as those proposed are fixed in the IoT bring advantages in terms of perception, transmission and application of information in the field perspectives of health and medical care. Enabling smart, an accessible and communication system based on IoT hosting segments such as: medical equipment, information management control medication of patients, telemedicine, mobile medical care, and personal health management, among others.

Home automation or Smart Homes (also known as domotic) can be described as introduction of technology within the home environment to provide convenience, comfort, security and energy efficiency to its occupants [13]. Adding intelligence to home environment can provide increased quality of life for the old-people and disabled people who might otherwise need caregivers or institutional care.

There hase been a significant gruth in home automation lastely due to higher affordability and progression in Smart phones and tablets which permits huge and easy connectivity. With the introduction of the IoT, the studies and employment of smart homes are getting more popular [6]. Much of the research attention has been given in academic research laboratories. Several wireless communication technologies that can support some form of distant data transmission, detecting and control such as Bluetooth, Wi-Fi, RFID, and cellular networks have been used to insert numerous stages of intelligence in the household [14]. Researches in [13, 14] have intreduced Bluetooth based home automation systems using Smart phones without the Internet controllability. The appliances are physically connected to a Bluetooth sub-controller which is then accessed and controlled by the Smart phone utilizing built-in Bluetooth connectivity. However, due to limited distance of operation (up to 100 m only) the network is incapable to manage with mobility and can only be controlled within the vicinity. Academics have also tried to provide network interoperability and distant access to control appliances at the house based on home-gateways. [17] Presented a Wi-Fi using home control system based on web server which accomplishes the connected home appliances.

A GSM based communication and control for home devices has also been introduced by [18] where diverse AT commands are transmited to the House Mobile for controlling diverse devices. The disadvantage of this network is that manipulators are not provided with a graphical user interface and they have to remember diverse AT commands to control the attached appliances.

The above cited systems have made momentous contributions to the design and improvement of domotic systems. Though, the current works were generally focused on switching and controlling home devices or connected appliances rather than distantly monitoring of home environment.

3. THE PROPOSED SYSTEM: SMIS

This section describes the proposed architecture and design of flexible and low cost controlling and monitoring system. The architecture is divided into three layers: monitoring area, communication module and Remote Environment (smartphone, tablet). Remote Environment represents authorized users who can visualize the sensed data on their Smart phone using sms via GSM. Monitoring district consists of a software and a hardware interface module as demonstrated in the Figure 1 below.

The diagram of the control system of Figure 1 can be divided into two parts:

a. The top part includes a GSM module, tablets, smart phones, etc.A tablet or smartphone serves as a remote control via GSM.
b. The lower part includes an intelligent central controller, RF modules, control modules, environmental modules, data collectors, and so on. The intelligent central controller is a link between the previous and the next in that it combines the top and the bottom. He is responsible for setting up a WSAN RF433 MHz (Wireless Sensors & Actors Network) in a studied envirement. These versatile control modules are responsible for controlling the devices and communicating with the central controller.

The smart control system is effective due to the following advantages:
– It maintains a dynamic balance through self-configuration and self-organization.
– It is easy to set up and maintain.
– The control modules have been designed in standard sizes.
The controller and these modules constitute a WSAN.

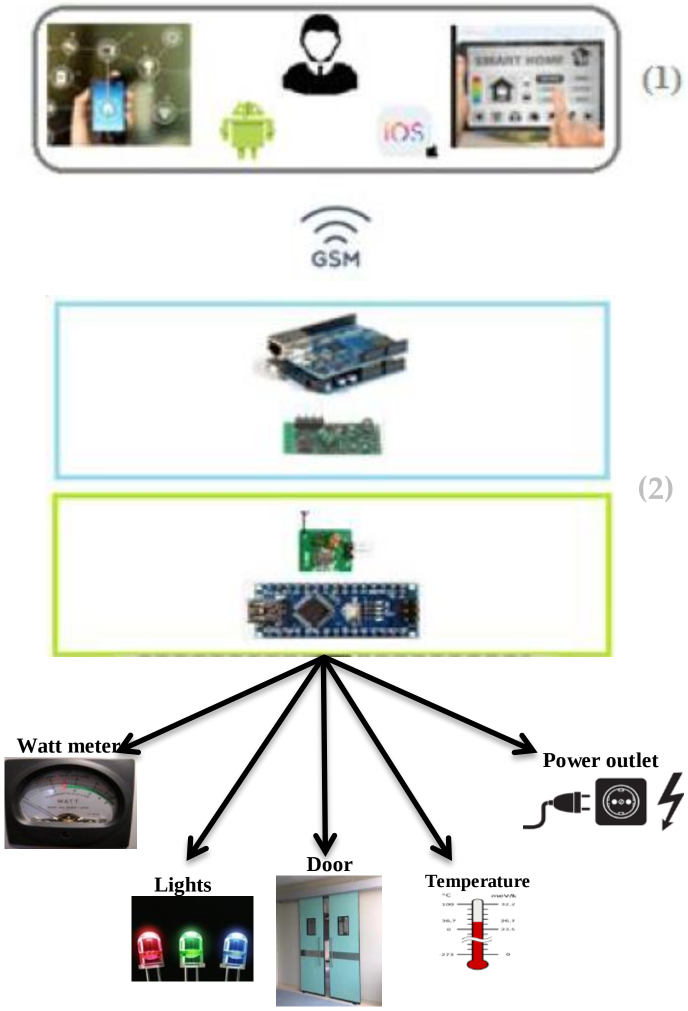


Figure 1. The proposed remote monitoring system

4. A WIRELESS SENSOR AND ACTUATOR NETWORK

Wireless communications namely Zigbee, Wi-Fi, Bluetooth and 433 MHz, have been widely used in many applications recently. the following Table 1 gives a comparison between these wireless technologies in terms of band operated, energy consumption, range, debit and battery life [19]:

Table 1. Comparison between these wireless technologies

Wireless Technologies	Band perated	Energy consumption	Transmission distance	Battery life	debit
Zigbee	2.4GHz	high	Small to medium	few days	<1Mbps
Wi-Fi	2.4GHz	high	Small to medium	few days	1->54Mbps
RF	433MHz	low	medium to large	up to 10 years	9.6Kbps

433 MHz wireless communication is available worldwide and an open source alternative. It is ideal for wireless sensor network applications because it can transmit / receive over very long distances without requiring high power consumption on a battery. The low input current of typical label configurations can power button cell batteries or thin-film batteries up to 10 years.

However, the 433 MHz bit rate is only 9.6 kbps, making it ideal for applications in which only a small amount of data needs to be transmitted. Therefore, it is generally used for modern control systems. Our WSAN used RF433 MHz wireless communication. It adopts a star topology in which the microcontroller forms the main part and is responsible for building the entire 433 MHz wireless network. Flowcharts Figure2, Figure3 bellow describes operation steps of the proposed system:

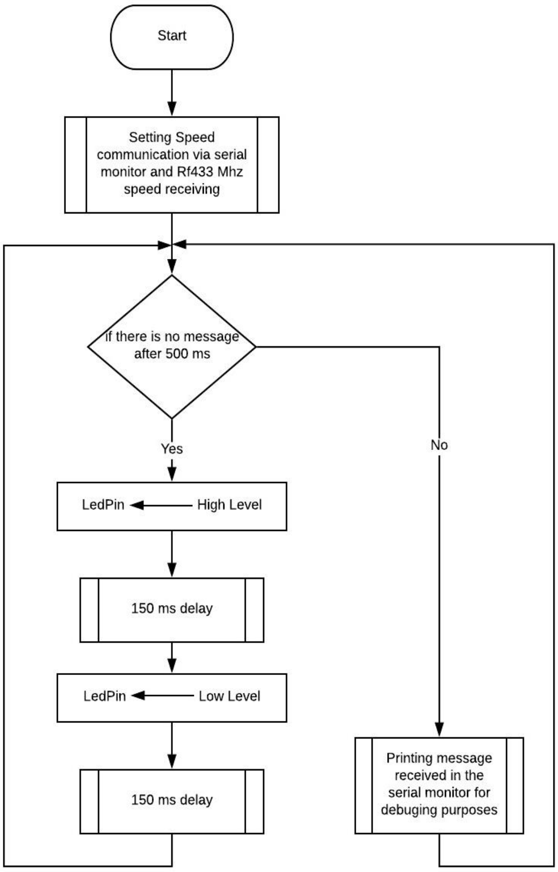


Figure 2. Operation steps of the proposed system

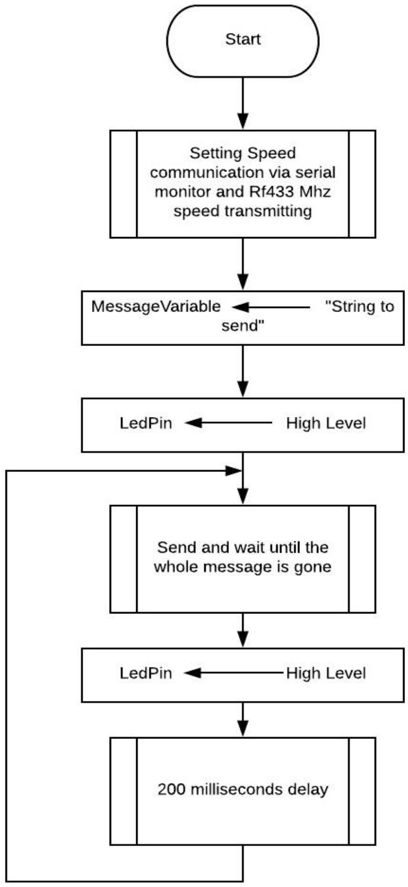


Figure 3. Operation steps of the proposed system

5. EXPERIMENTAL RESULTS OF THE FUNCTION

Linear model Poly9:

$$f(x) = \sum_{n=1}^{10} p_n * x^{10-n} \quad (1)$$

where x is normalized by mean 1.36 and std 0.8332
Coefficients (with 95% confidence bounds):
p1 = 0.1216 (-0.004683, 0.2478)
p2 = -0.2144 (-0.4598, 0.03102)
p3 = -0.3513 (-1.035, 0.3319)
p4 = 0.9463 (-0.2019, 2.095)
p5 = -0.2711 (-1.68, 1.138)
p6 = -1.502 (-3.206, 0.2034)
p7 = 1.415 (0.177, 2.652)
p8 = 1.635 (0.7719, 2.499)
p9 = 2.029 (1.679, 2.38)
p10 = 3.775 (3.668, 3.883)

The (1) is given by interpolation with the Newton method, and presents the following correlation performance reaches 99.94%, the following table gives a summary of these performances:

Table 2. Goodness of fit

SSE	R-square	Adjusted R-square	RMSE
0.166	0.9994	0.9991	0.1052

Where SSE is Sum squared error performance function, R-square is the square of the correlation between the response values and the predicted response values. It is also called the square of the multiple correlation coefficient and the coefficient of multiple determination, RMSE (Root Mean Squared Error) is known as the fit standard error and the standard error of the regression.

The measures that have been taken on a wire alloy copper 2mm diameter for the RF module depending on the transmission distance.

Table 3. This table presents measurements of RF's range and antenna's length

Number of measurestaken	Antennalength(cm)	RF433MHz Range (m)
25	0,1	0,67
24	0,2	1
23	0,3	1,29
22	0,4	1,55
21	0,5	1,61
20	0,6	1,9
19	0,7	2,18
18	0,8	2,48
17	0,9	2,77
16	1	3,11
15	1,1	3,33
14	1,2	3,58
13	1,3	3,65
12	1,4	3,72
11	1,5	4,06
10	1,6	4,47
9	1,7	4,96
8	1,8	5,5
7	1,9	5,98
6	2	6,49
5	2,2	7,55
4	2,4	8,61
3	2,6	9,66
2	2,8	10,53
1	3	14,78

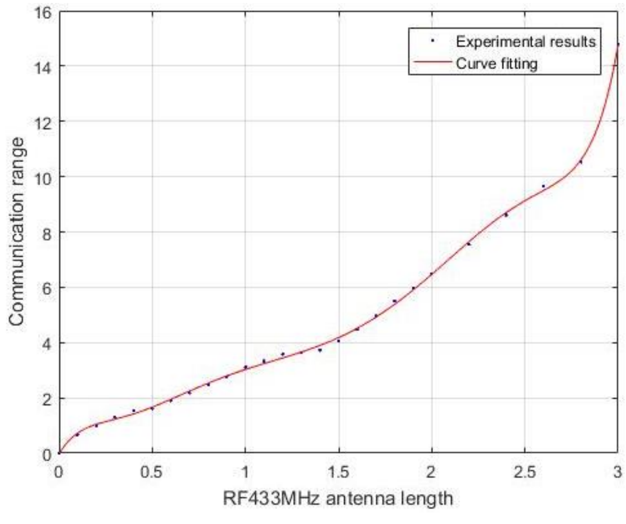
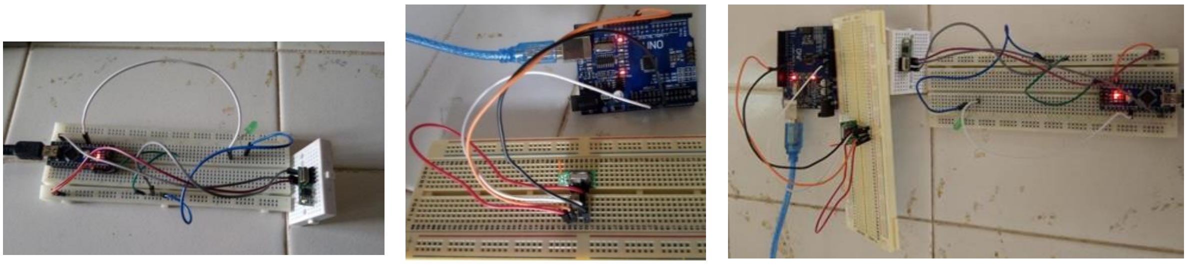


Figure 4. Communication range vs RF433MHZ antenna lentgh

6. DESIGN AND IMPLEMENTATION

To manage the monitored objects remotely in specific studied area (smart home, health care, smart grid ...), it is necessary to develop a smart monitoring information system (SMIS), which can be run in a management system or on the owner's computer. We designed and developed a SMIS with arduino, smart sensors and RF433 MHZ technologies. The SMIS includes RF emitter, RF receiver, data gathering unit (Arduino Uno) and controlled objects (attached to arduino Nano), transmission module (GSM).

SMIS operates in real time, at every 500ms the emitter starts the mission by sending a message to the RF 433MHZ receiver, since the remotely monitored object is included in the monitored area. If the receiver RF doesn't get any messages from the emitter, the SMIS send an SMS to the object's owner over the GMS module and activates the buzzer to tell that the object is out of the monitored area.



(1) (2) (3)

Figure 5. (1),(2) and (3) are SMIS implementation

7. CONCLUSION

The IoT-based object control system proposed in this document adopts the 433 MHz wireless sensor and actuator network as a low layer, which facilitates remarkably reconfiguration and reorganization. An object owner can implement its monitoring, control and management on site or remotely by a smart terminal with GSM. Since the object control system combines a 433 MHz wireless sensor and actuator communication network with the Internet, it can be used for power grid control, environmental monitoring, or intelligent transportation without requiring major material modification.

Enhancing energy efficiency of the actuators can reduce energy costs and emissions. After the construction of an object control system, an essential goal of the future is to manage all actuators and optimize their operation. Our current mission is to study optimal control strategies for applications that save energy in actuators.

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